Ch. 11 Warm Up

1. Who was Gregor Mendel and what was his major contribution to science?

2. Draw Punnett Squares to show the outcomes of the following crosses:
   A. AA X aa
   B. Aa X aa
   C. Aa X Aa

Ch. 11 Warm Up

1. What is a test cross? How is it used?

2. R = tongue roller, r = nonroller

   What would be the genotypic and phenotypic ratios for a cross between a heterozygous tongue roller and a non-roller?

3. Given: D = dimples, d = no dimples

   What traits would the children of 2 parents (Rrdd and rrDd) have?

Ch. 11 Warm Up

1. What is the probability that the following pair will produce the indicated offspring?
   - AABBCC X aabbcc -> AaBbCc
   - AABbCc X AaBbCc -> AAbbCC

2. Cross AaBb X Aabb. What is the probability of A__B__? That the baby will phenotypically resemble parent 1?

1. Mom is A+. She has 2 children, one is O+ and the other is B-. (Note: Rh+ is RR or Rr, and Rh- is rr) What are the father's possible genotypes?

Ch. 11 Warm Up

1. What is the probability that the following cross will produce the indicated offspring?
   A. RR X Rr -> RR
   B. AABB x aabb -> AaBb
   C. AABbCc X AaBbCc -> AAbbCC

2. A couple has 2 children, both blonds with brown eyes. The parents are both brown eyed (BB), one with blond hair (rr) and one red (Rr). What is the probability the next child is a brown eyed redhead?

Mendel And The Gene Idea

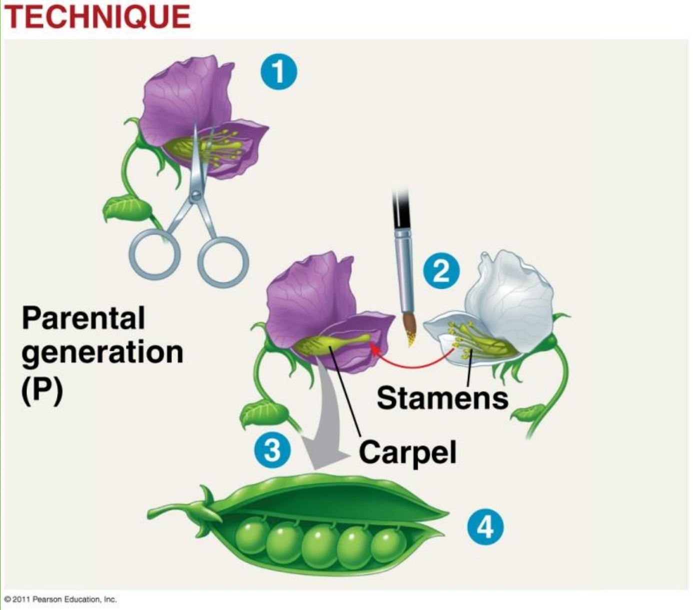
CHAPTER 11

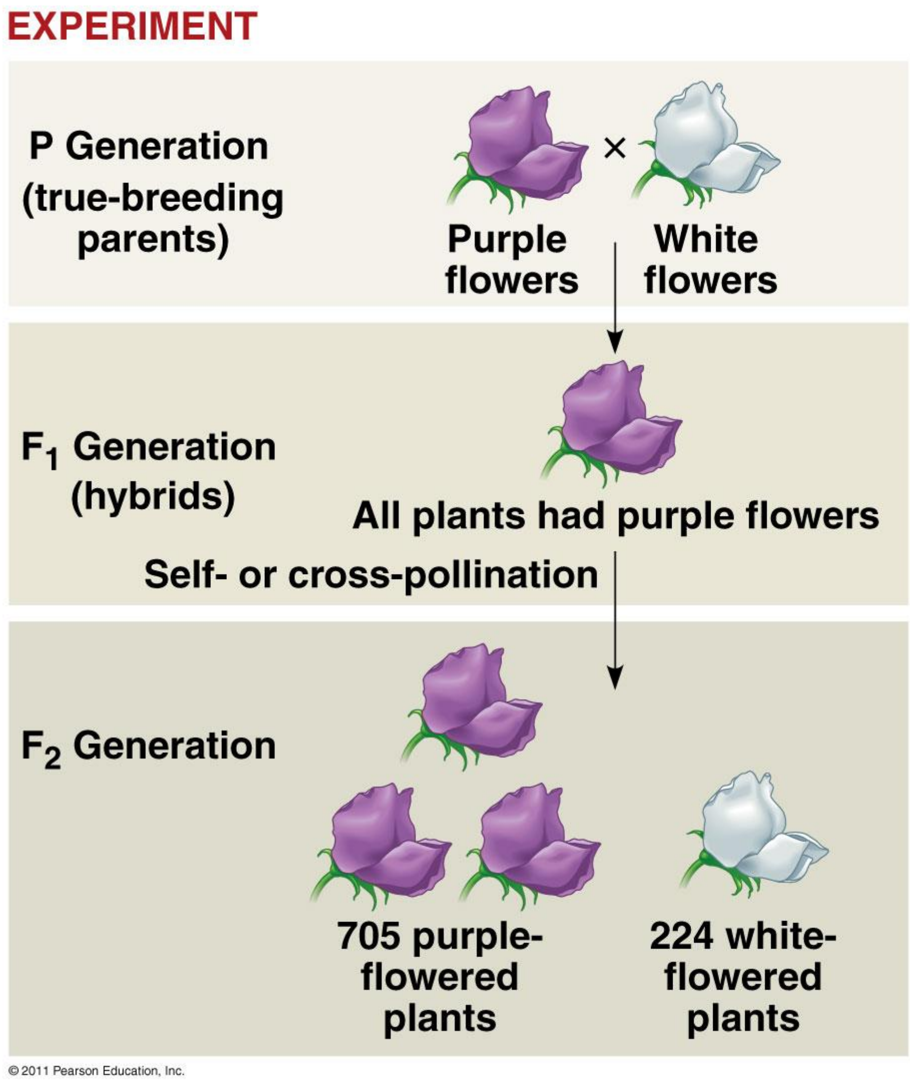
What You Need To Know:

- Terms associated with genetics problems: P, F_1, F_2, dominant, recessive, homozygous, heterozygous, phenotype, and genotype.
- How to derive the proper gametes when working a genetics problem.
- The difference between an allele and a gene.
- How to read a pedigree.
- How to use data sets to determine Mendelian patterns of inheritance.

Gregor Mendel

- Austrian monk
- Brought experimental and quantitative approach to genetics
- Bred pea plants to study inhertance
- Why peas?
  - Control mating (self- vs. cross-pollination)
  - Many varieties available
  - Short generation time





- P (parental) generation = true breeding plants
- F_1 (first filial) generation = offspring
- F_2 (second filial) generation = F_1 offspring

Table 11.1 **The Results of Mendel's F_1 Crosses for Seven Characters in Pea Plants**

Character	Dominant Trait	×	Recessive Trait	F_2 Generation Dominant: Recessive	Ratio
Flower color	Purple 	×	White 	705:224	3.15:1
Seed color	Yellow 	×	Green 	6,022:2,001	3.01:1
Seed shape	Round 	×	Wrinkled 	5,474:1,850	2.96:1
Pod shape	Inflated 	×	Constricted 	882:299	2.95:1
Pod color	Green 	×	Yellow 	428:152	2.82:1
Flower position	Axial 	×	Terminal 	651:207	3.14:1
Stem length	Tall 	×	Dwarf 	787:277	2.84:1

7 characters in pea plants

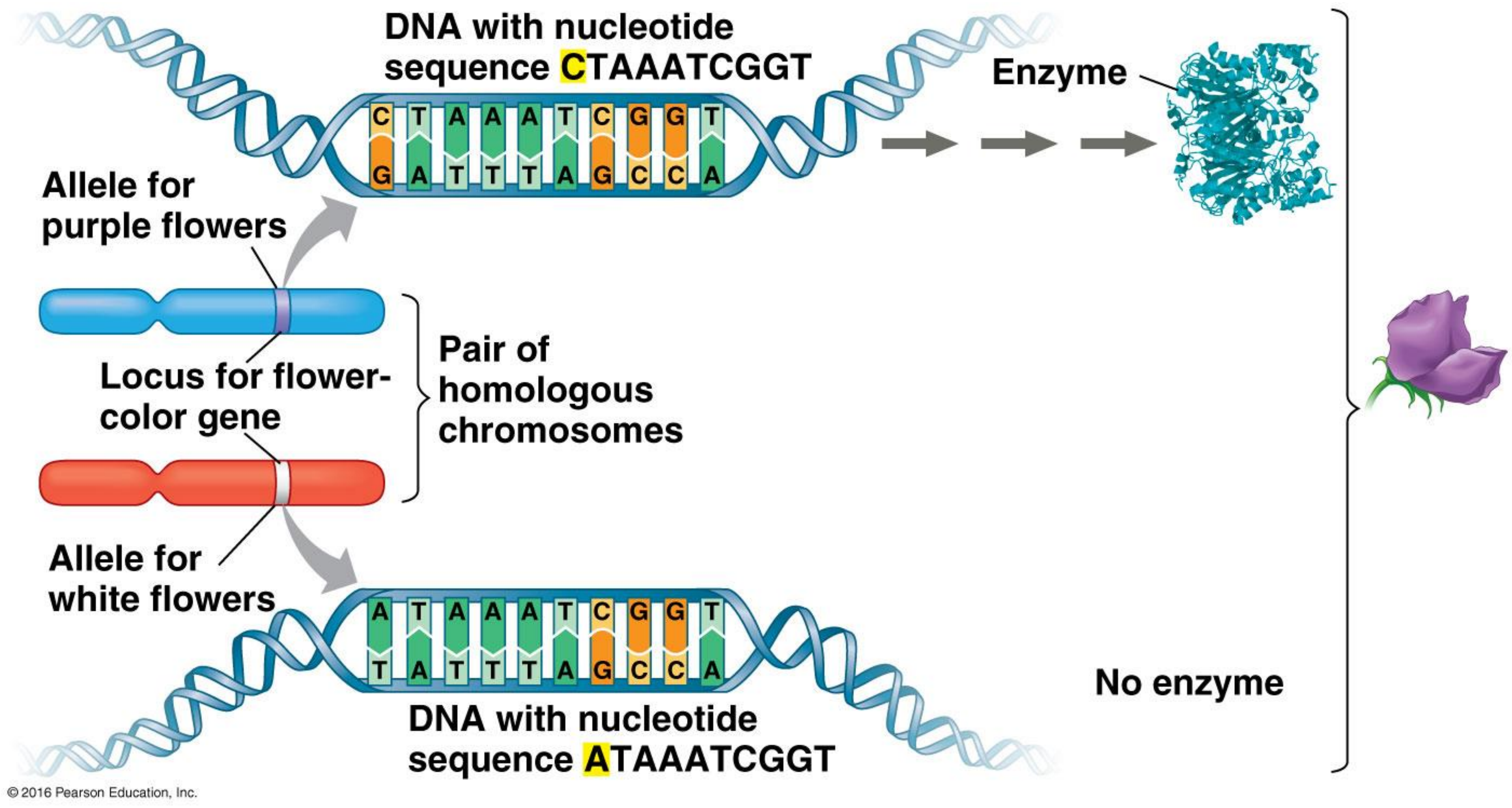
Dominant vs. **Recessive**

(expressed) or (hidden)

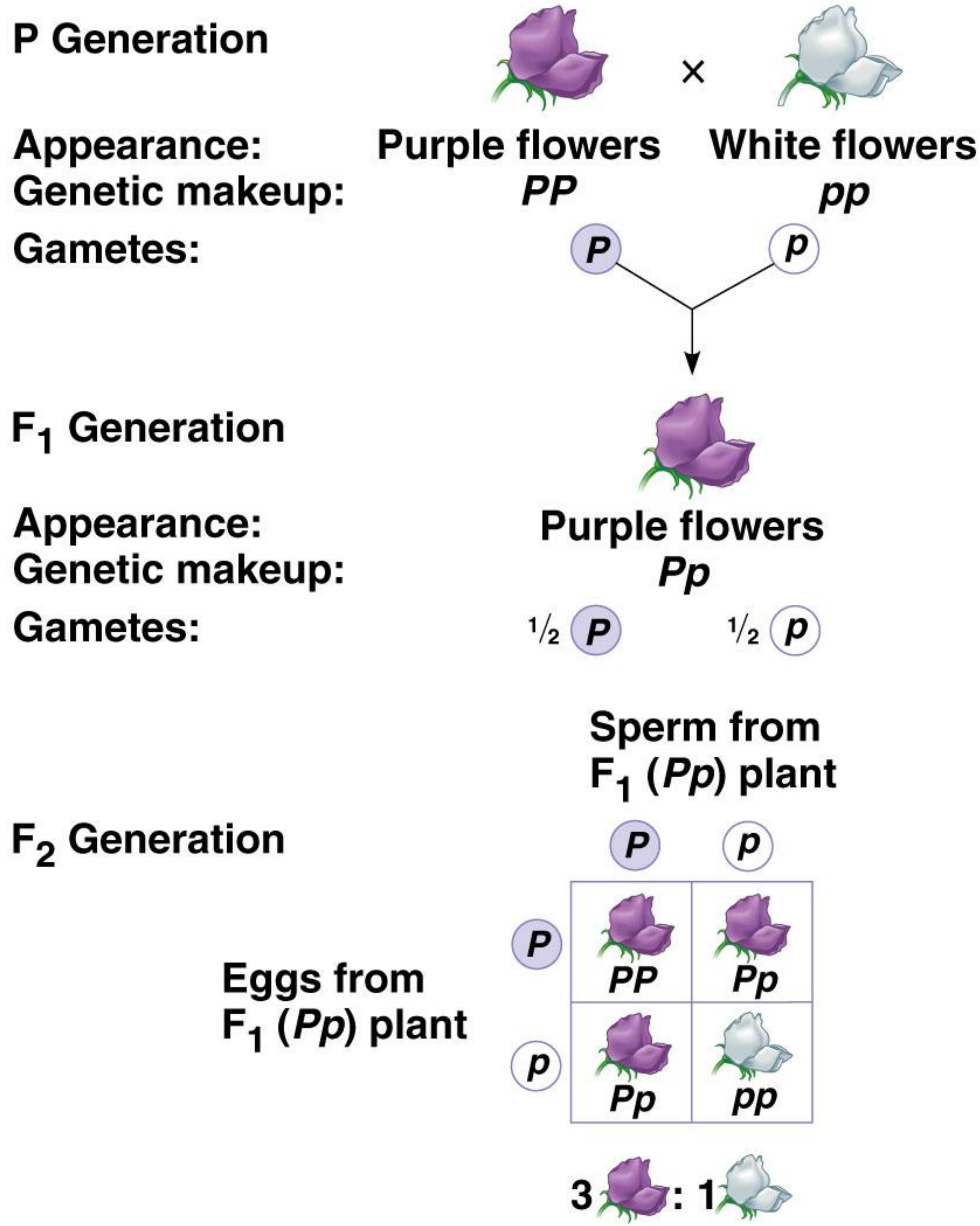
Mendel's Principles

1. Alternate version of genes (alleles) cause variations in inherited characteristics among offspring.
2. For each character, every organism inherits one allele from each parent.
3. If 2 alleles are different, the dominant allele will be fully expressed; the recessive allele will have no noticeable effect on offspring's appearance.
4. Law of Segregation: the 2 alleles for each character separate during gamete formation.

Alleles: alternate versions of a gene

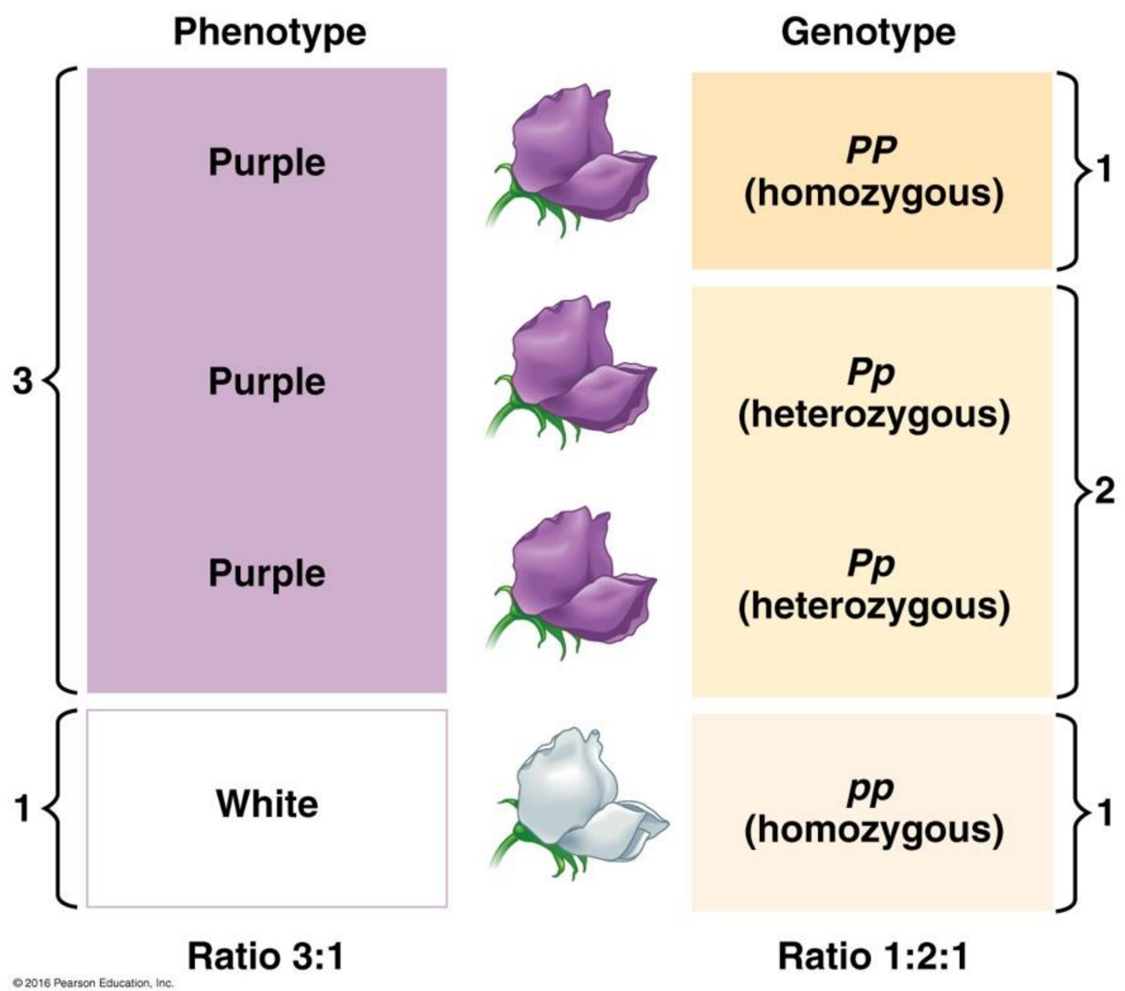


Law of Segregation

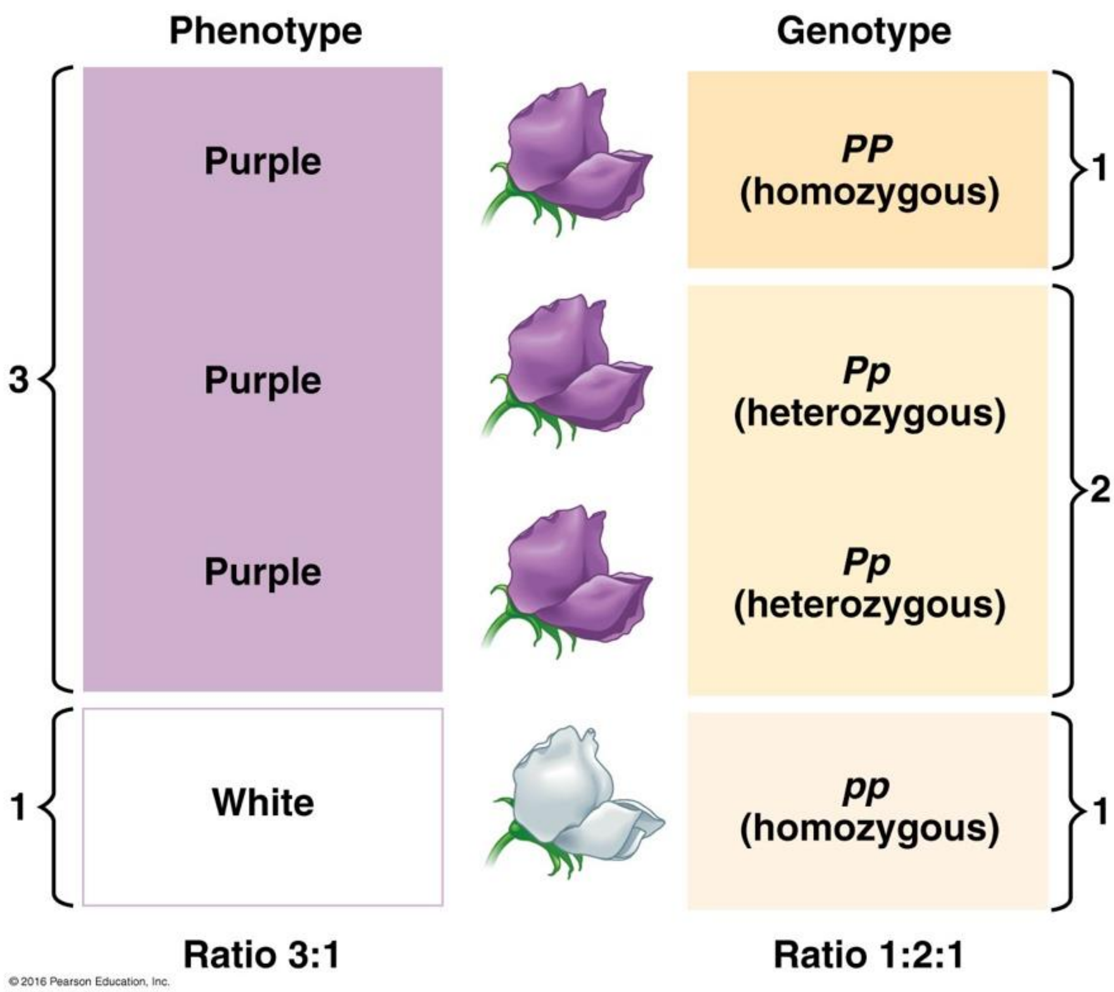


Dominant (P), recessive (p)

- homozygous = 2 same alleles (PP or pp)
- heterozygous = 2 different alleles (Pp)



- **Phenotype**: expressed physical traits
- **Genotype**: genetic make-up



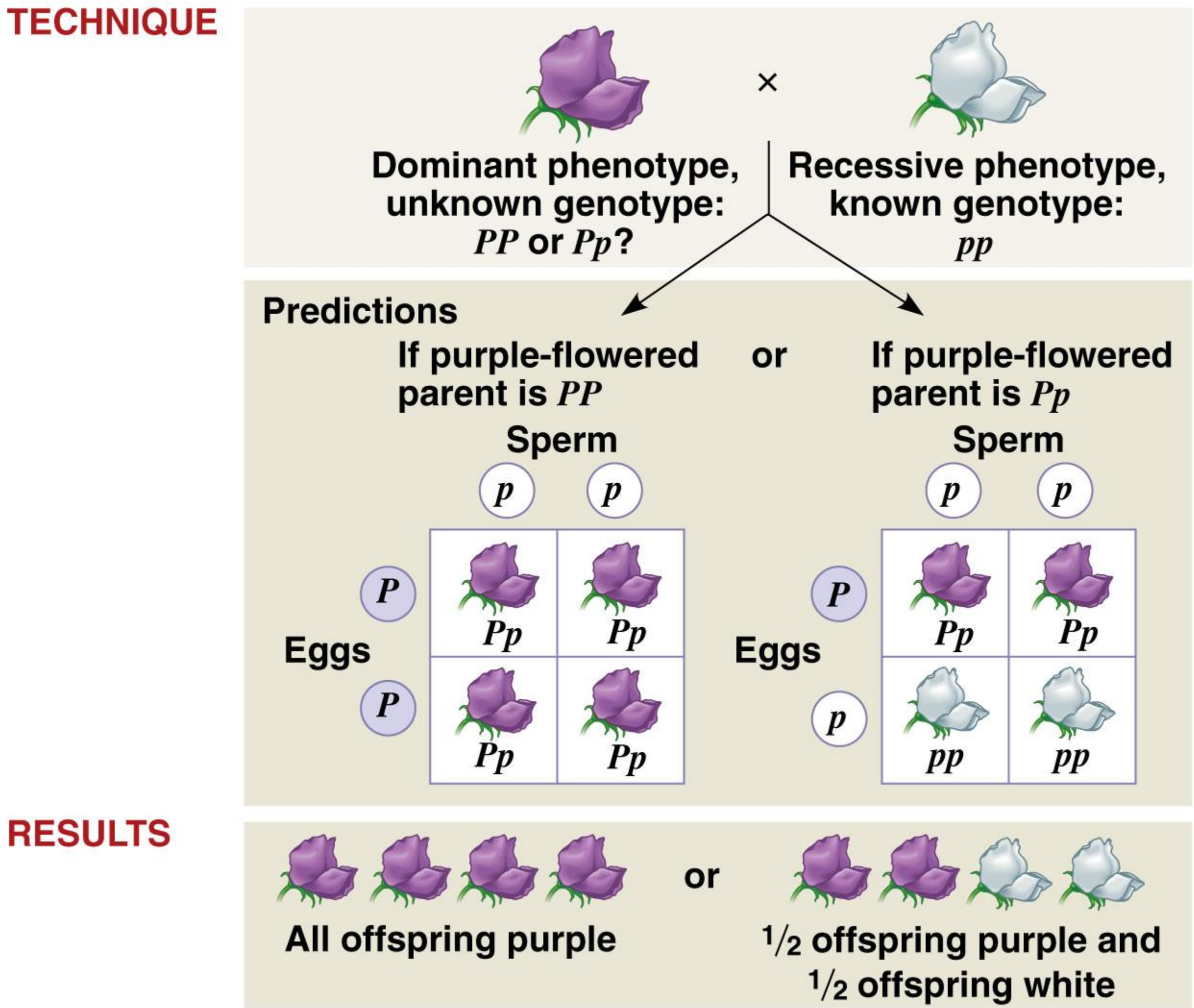
Punnett Square

- Device for predicting offspring from a cross
- Example: Pp x Pp (P=purple, p=white)

Genotypic Ratio:

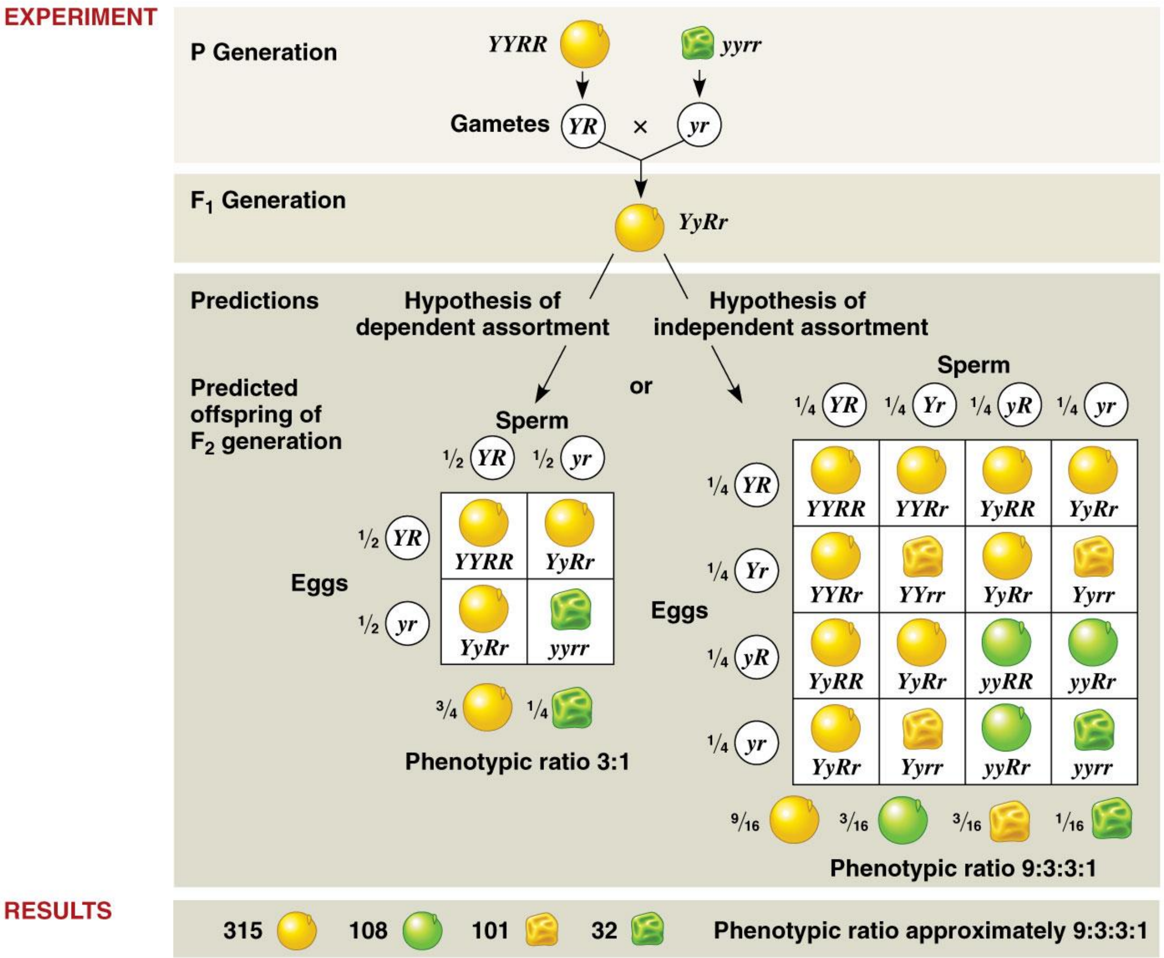
Phenotypic Ratio:

Testcross: used to determine if *dominant trait* is unknown (homozygous or heterozygous?) by crossing with *recessive (pp)*



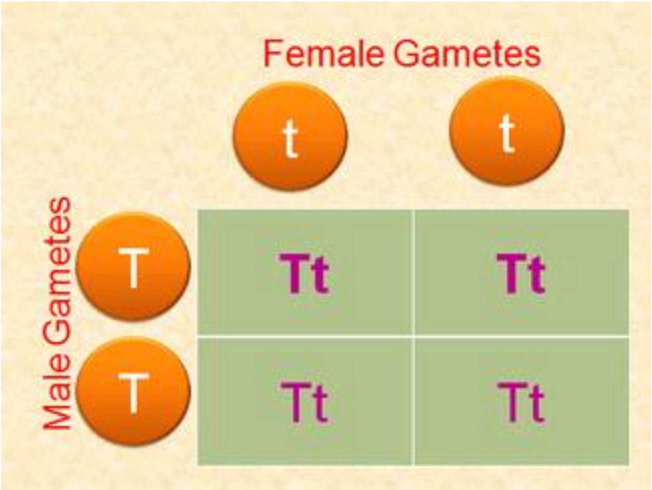
Law of Independent Assortment:

- Each pair of alleles segregates (separates) independently during gamete formation
- Eg. color is separate from shape



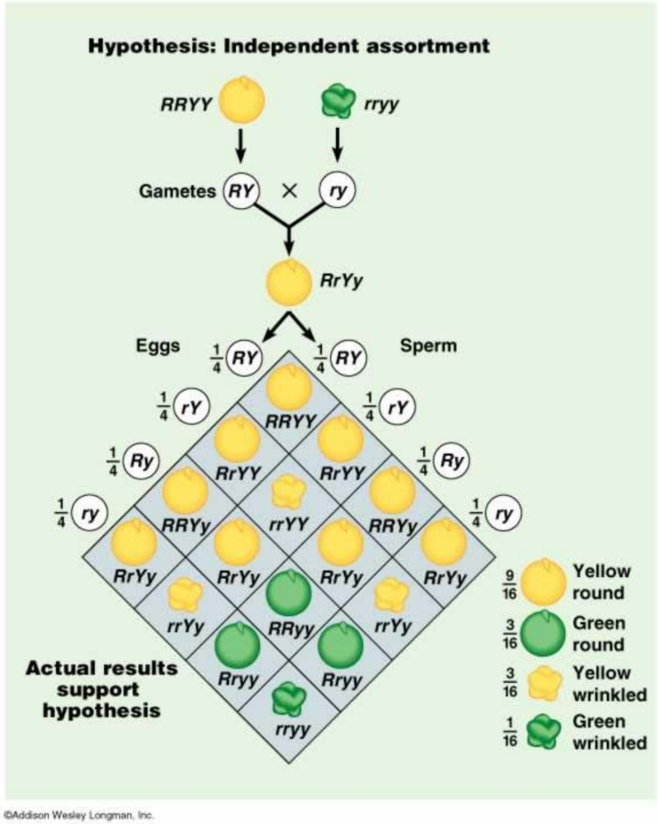
Monohybrid Cross: study 1 character

- eg. flower color



Dihybrid Cross: study 2 characters

- eg. flower color & seed shape



Dihybrid Cross

- Example: AaBb x AaBb

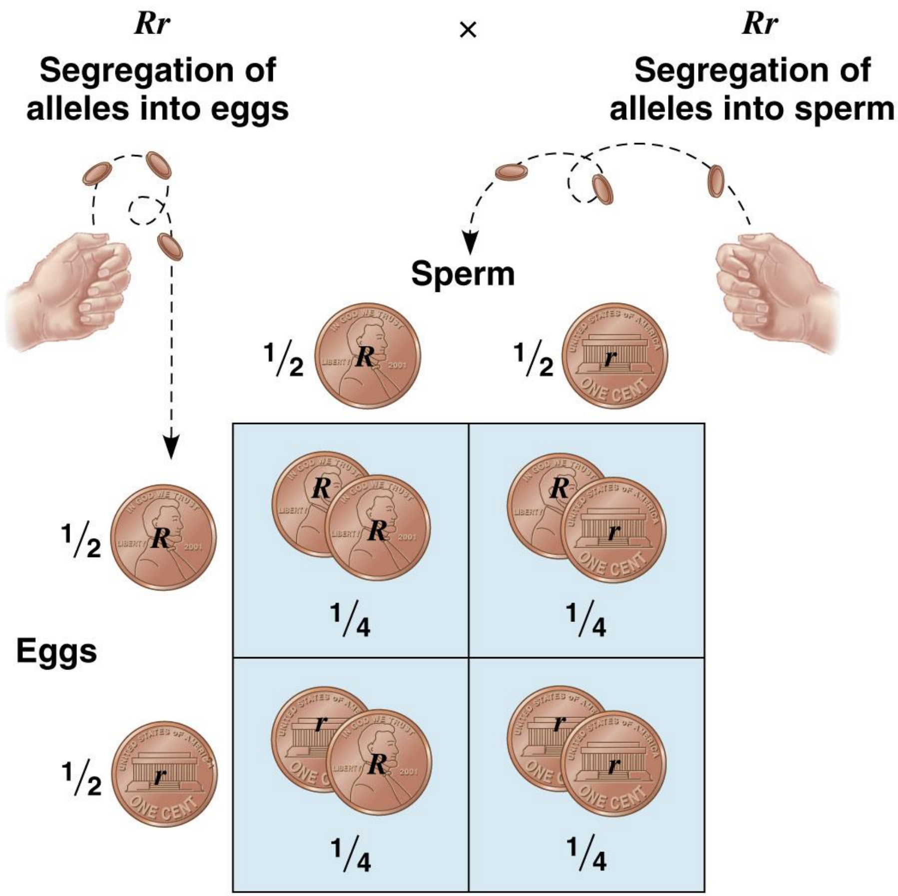
The laws of probability govern Mendelian inheritance

- Multiplication Rule:
  - Probability that 2+ independent events will occur together in a specific combination → multiply probabilities of each event
- Ex. 1: probability of throwing 2 sixes
  - 1/6 x 1/6 = 1/36
- Ex. 2: probability of having 5 boys in a row
  - ½ x ½ x ½ x ½ x ½ = 1/32
- Ex. 3: If cross AABbCc x AaBbCc, probability of offspring with AaBbcc is:
  - *Answer: ½ x ½ x ¼ = 1/16*

The laws of probability govern Mendelian inheritance

- Addition Rule:
  - Probability that 2+ mutually exclusive events will occur → add together individual probabilities
- Ex. 1: chances of throwing a die that will land on 4 or 5?
  - $1/6 + 1/6 = 1/3$

Segregation of alleles and fertilization as chance events



Extending Mendelian Genetics

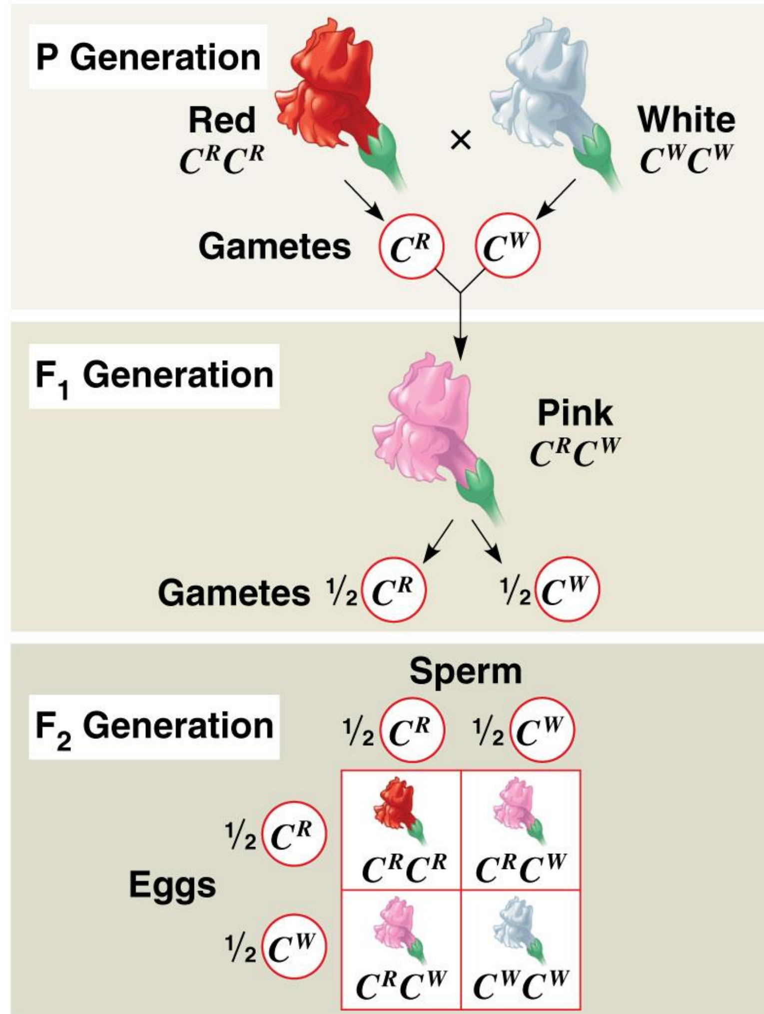
The relationship between genotype and phenotype is rarely simple

<u>Complete Dominance</u>: heterozygote and homozygote for dominant allele are indistinguishable

- Eg. YY or Yy = yellow seed

<u>Incomplete Dominance</u>: F_1 hybrids have appearance that is between that of 2 parents

- Eg. red x white = pink flowers



Codominance: phenotype of both alleles is expressed

- Eg. red hair x white hairs = roan horses

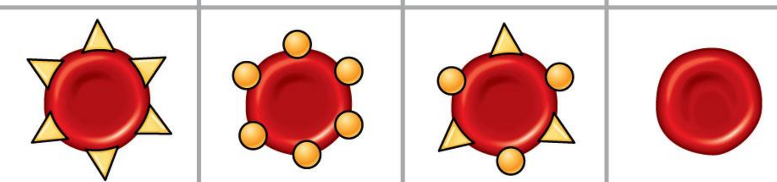
Multiple Alleles: gene has 2+ alleles

- Eg. human ABO blood groups
- Alleles = I^A, I^B, i
- I^A,I^B = Codominant

(a) The three alleles for the ABO blood groups and their carbohydrates

Allele	I^A	I^B	i
Carbohydrate	A △	B ○	none

(b) Blood group genotypes and phenotypes

Genotype	I^AI^A or I^Ai	I^BI^B or I^Bi	I^AI^B	ii
Red blood cell appearance				
Phenotype (blood group)	A	B	AB	O

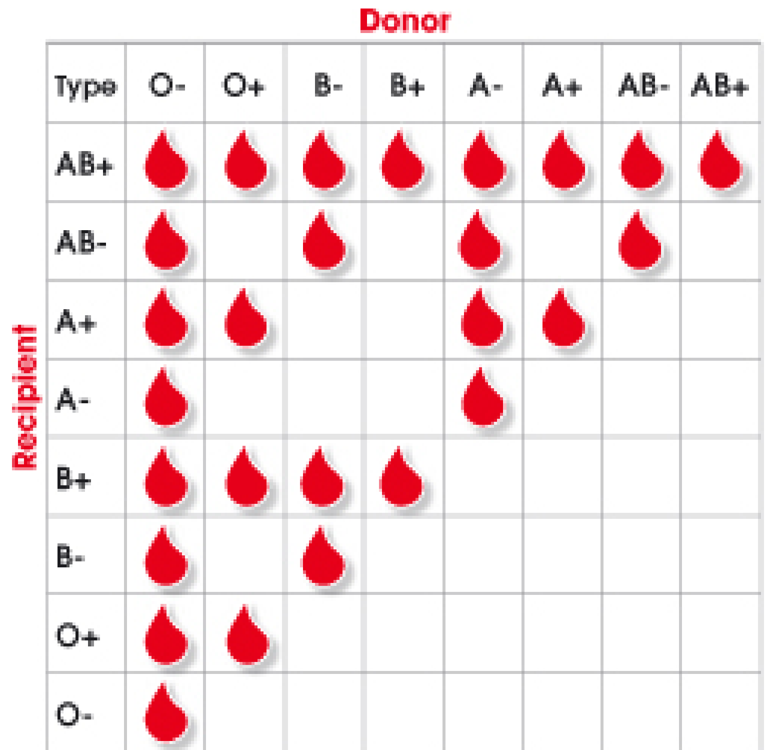
Blood Typing

Phenotype (Blood Group)	Genotype(s)
Type A	I^AI^A or I^Ai
Type B	I^BI^B or I^Bi
Type AB	I^AI^B
Type O	ii

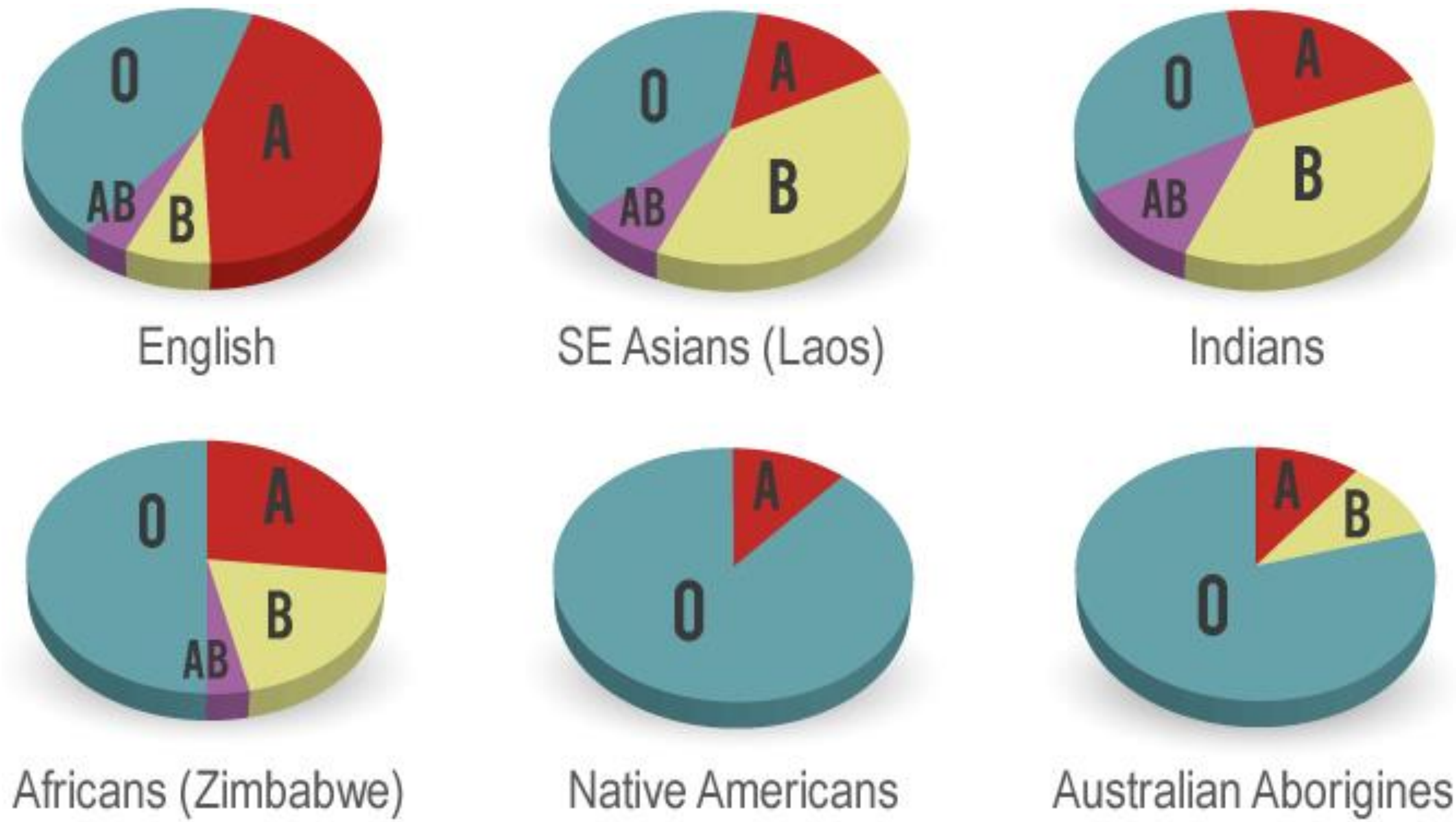
Practice Problem #1:

- A man who is heterozygous with type A blood marries a woman who is homozygous with type B blood. What possible blood types might their children have?

Blood Transfusions



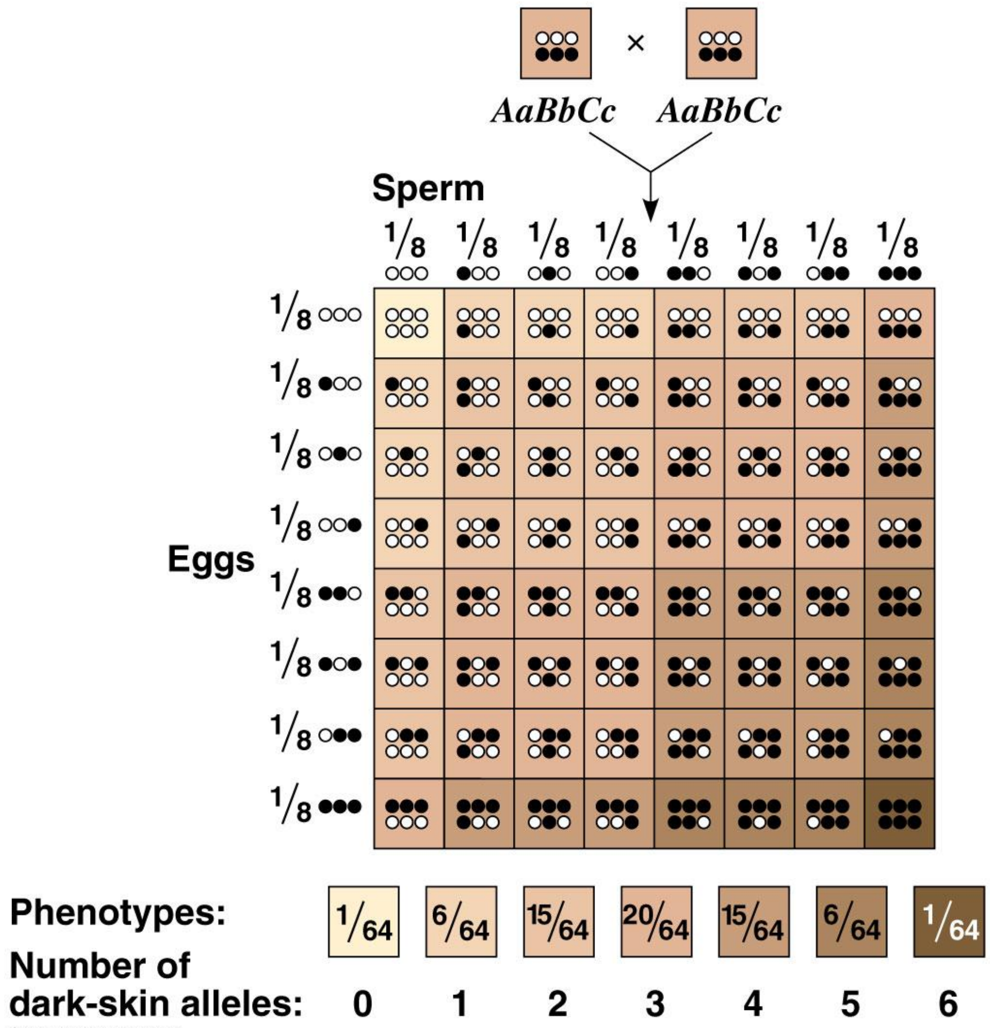
- Blood transfusions must match blood type
- Mixing of foreign blood → clumping → death
- Rh factor: protein found on RBC's (Rh+ = has protein, Rh- = no protein)


O
A
AB
B
English
O
A
AB
B
SE Asians (Laos)
O
A
AB
B
Indians
O
A
B
AB
Africans (Zimbabwe)
A
O
Native Americans
A
B
O
Australian Aborigines

Practice Problem #2

- Babies Jane (blood type B), John (blood type O), and Joe (blood type AB) were mixed up in the hospital. Who are their parents?
  - Couple #1: A, A
  - Couple #2: A,B
  - Couple #3: B,O

Polygenic Inheritance: the effect of 2 or more genes acting upon a single phenotypic character (eg. skin color, height)



Nature and Nurture: both genetic and environmental factors influence phenotype

Hydrangea flowers vary in shade and intensity of color depending on acidity and aluminum content of the soil.

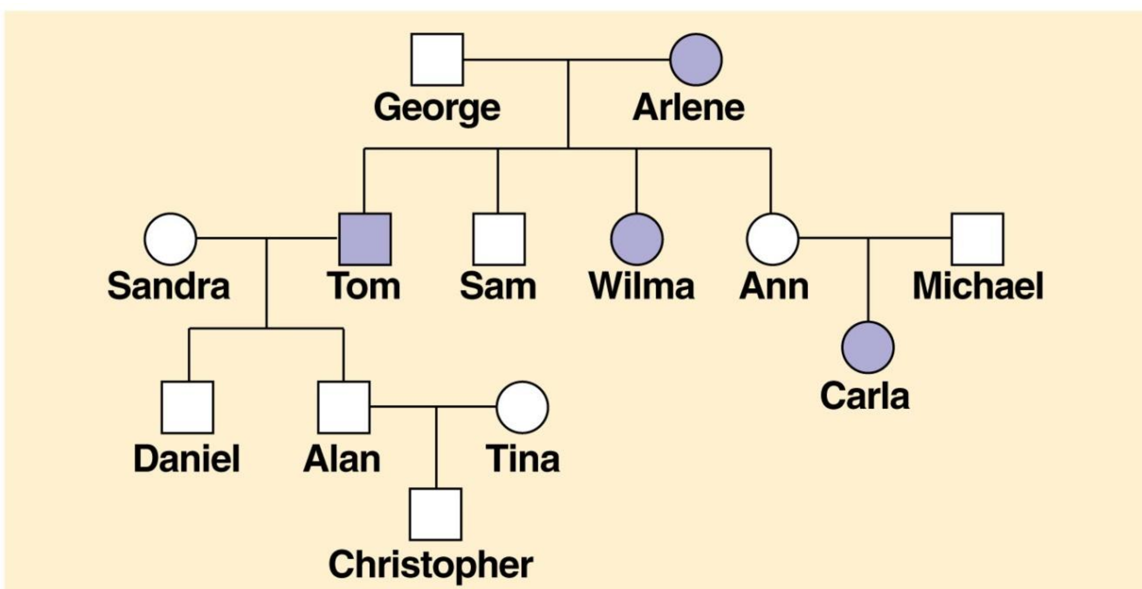
Mendelian Inheritance in Humans

<u>Pedigree</u>: diagram that shows the relationship between parents/offspring across 2+ generations

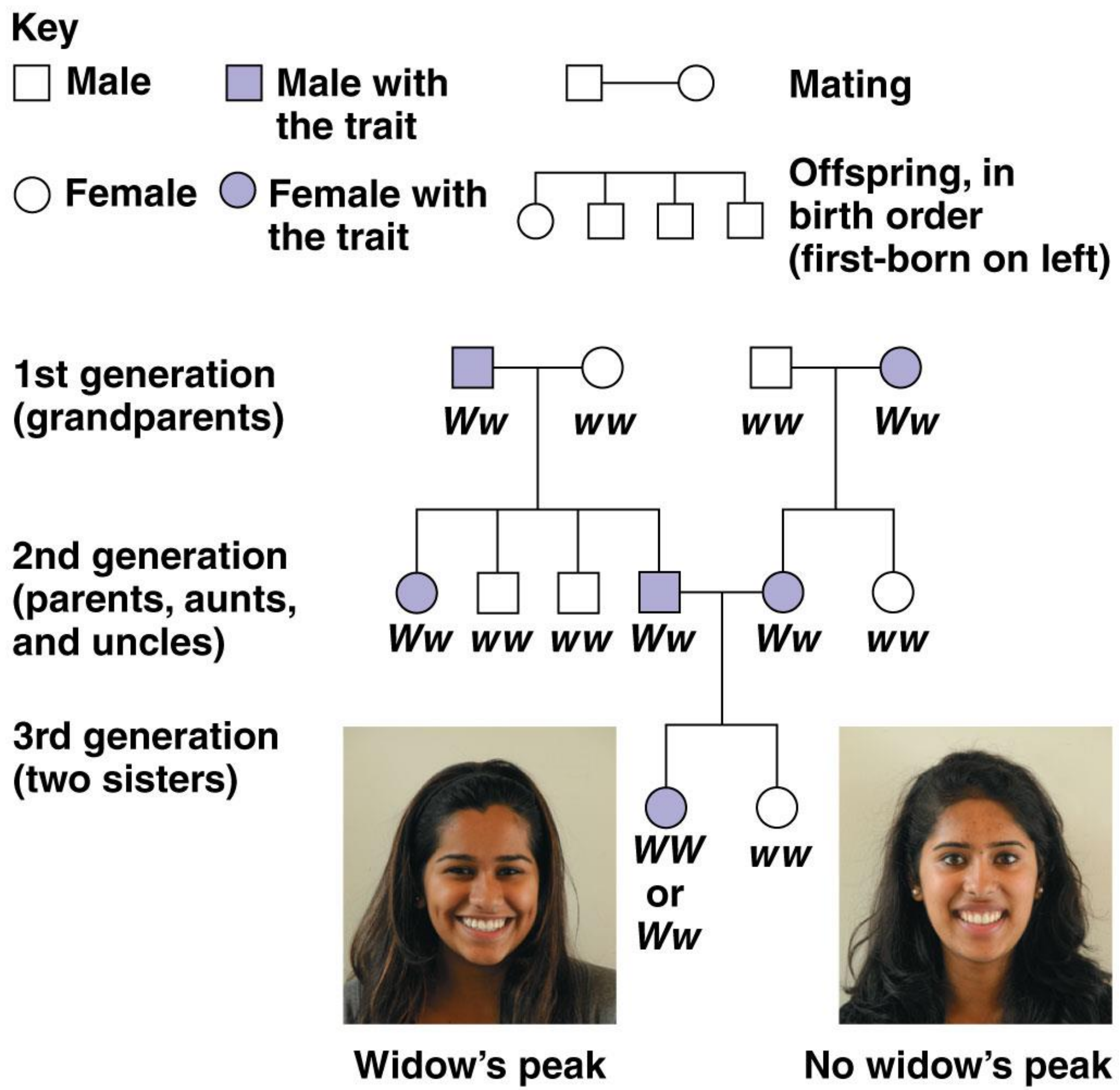
Woman = 

Man = 

Trait expressed: 

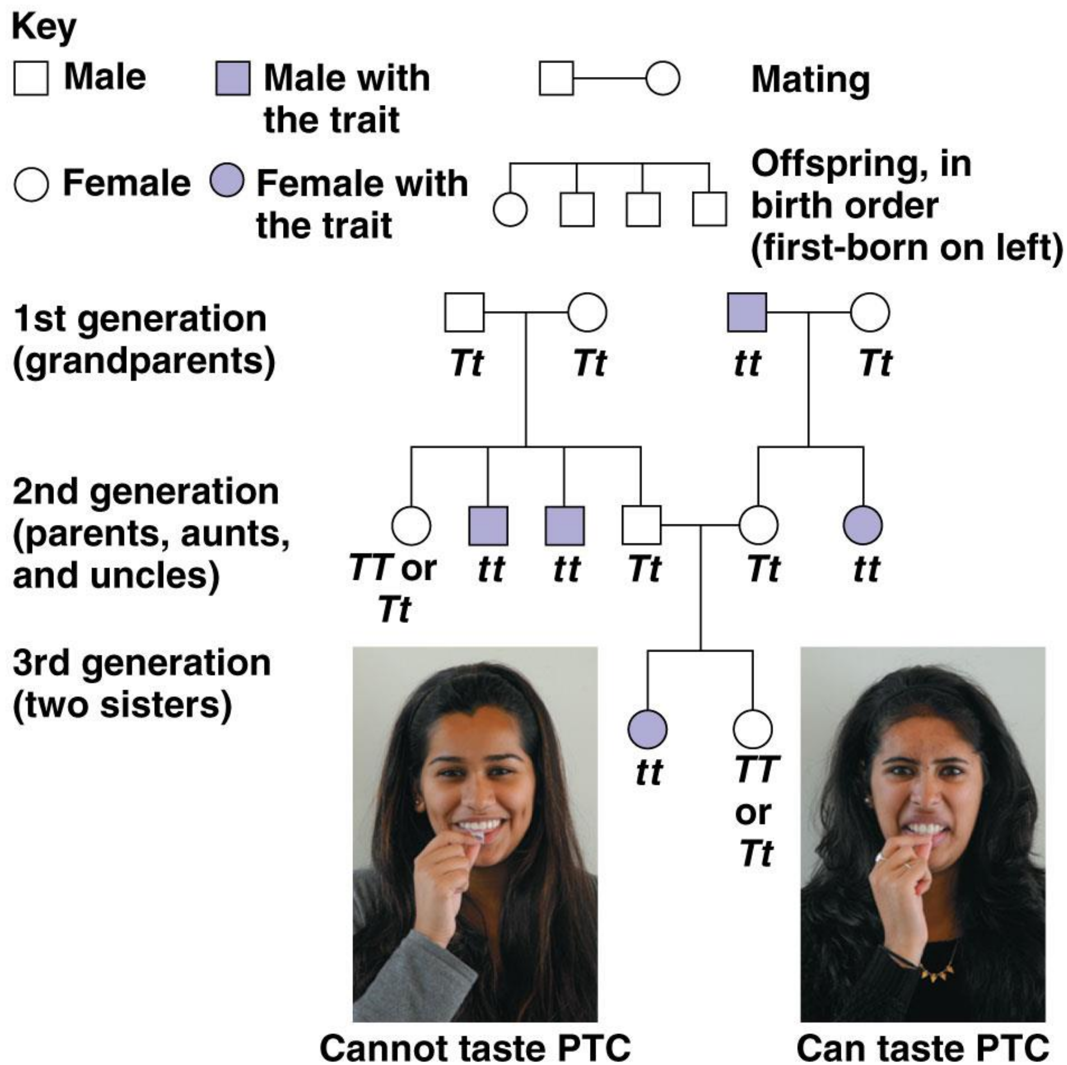


Pedigree Analysis: Widow's Peak Trait



(a) Is a widow's peak a dominant or recessive trait?

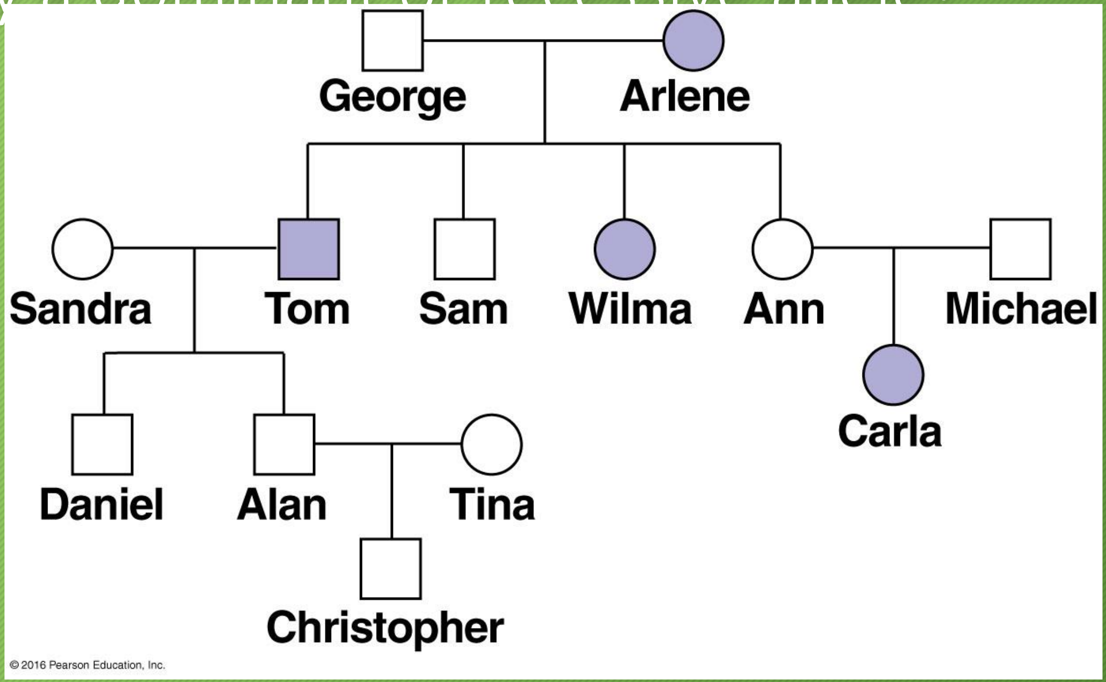
Pedigree Analysis: PTC Tasting



(b) Is the inability to taste a chemical called PTC a dominant or recessive trait?

Practice Problem #3

The pedigree below traces the inheritance of alkaptonuria, a biochemical disorder. Affected individuals are shaded. Does alkaptonuria appear to be caused by a dominant or recessive allele?



Genetic Disorders

Autosomal Recessive

- Albinism
- Cystic fibrosis (CF)
- Tay-Sachs disease
- Sickle-cell disease
- Phenylketonuria (PKU)

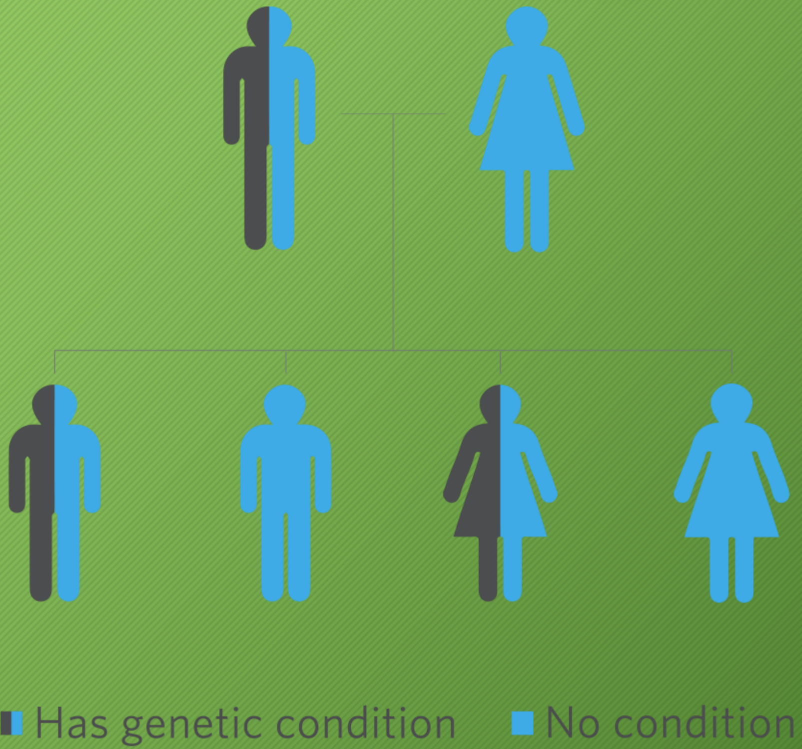
Autosomal Dominant

- Achondroplasia
- Huntington's disease (HD)
  - Lethal dominant allele

Multifactorial Disorders

- Heart disease
- Diabetes
- Cancer
- Alcoholism
- Mental illnesses (schizophrenia, bipolar disorder)

Genetic Counseling

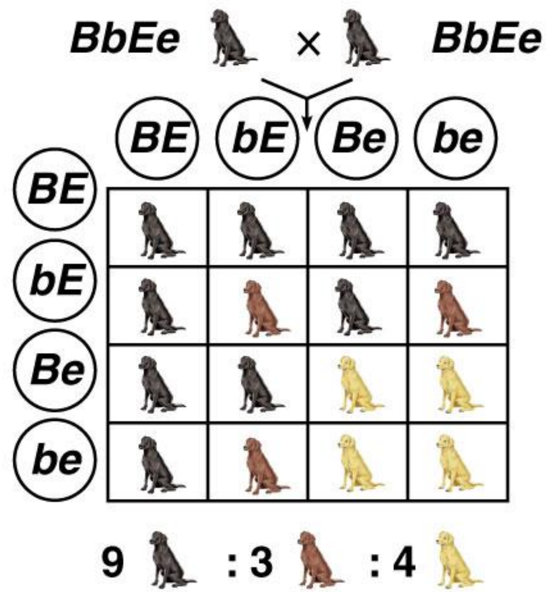


Practice Problems

1. Cystic Fibrosis is an autosomal recessive disorder. What are the chances that 2 carriers for this disease will have a child with CF?

2. Huntington's Disease is an autosomal dominant disorder. If a woman with this disease marries a normal man, what are the chances that their children will have the disease?

Relationship among alleles of a single gene	Description	Example
Complete dominance of one allele	Heterozygous phenotype same as that of homo-zygous dominant	*PP*  *Pp* 
Incomplete dominance of either allele	Heterozygous phenotype intermediate between the two homozygous phenotypes	 C^RC^R C^RC^W C^WC^W
Codominance	Both phenotypes expressed in heterozygotes	I^AI^B 
Multiple alleles	In the population, some genes have more than two alleles	ABO blood group alleles I^A, I^B, i
Pleiotropy	One gene affects multiple phenotypic characters	Sickle-cell disease

Relationship among two or more genes	Description	Example
Epistasis	The phenotypic expression of one gene affects the expression of another gene	
Polygenic inheritance	A single phenotypic character is affected by two or more genes